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ENGINEERING PROGRESS AND THE SOCIAL ORDER[1]

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AT a time like the present, we all realize that something is on trial. Without perhaps being particularly aware of it, civilized man the world over is engaged in sifting and weighing evidence and will sooner or later reach certain conclusions. These conclusions are likely to be of fundamental significance as regards the future ordering of public judgment, and will differ no doubt in important respects from the basic tradition which, in the past, has been acceptable and accepted in guiding much of our action.

It would be very interesting to discover just what it is that stands before the bar. It may be fundamental science, it may be applied science, it may be science and technology in general, it may be religion, it may be domestic politics or world politics, or it may only be that old and primeval scapegoat, human nature, whom the bailiff never tires of bringing to book and who, we now begin to suspect, is quite incorrigible.

Here in brief is the setting for any contemporary discussion of science and technology and their repercussions on the social order. In attempting to identify what is here somewhat loosely designated as the culprit, it is perhaps well to recognize that the public at large will make up its mind irrespective of what any few individuals decide. However, a correct analysis is none the less important because every cor-

[1] Address delivered before the Section on Natural Sciences of the University of Pennsylvania Bicentennial Conference, Philadelphia, September 19, 1940.

rect analysis helps to establish for the future our assurance that we are not utterly creatures of chance, but that if, as a social group, we make the requisite effort we will be able to gauge our social and political environment and build and modify it consciously, as we now control much of our material environment.

Let us begin with the truism that the major problems and troubles of the day have, in considerable measure, a technological and therefore a scientific heritage. Both our civilization and our civilization-destroying engines are mechanistic. In business and in industry—even in that much more fundamental unit, the family—the daily round has become pretty firmly geared to the machine. In optimistic moments we declare that this has brought leisure and has raised the standard of living; but if so, can we also affirm that it has brought liberty and peace of mind? Quite the reverse, for out of it has grown a powerful compulsion that we coordinate our individual and collective actions with almost machinelike precision to the complex activities that go to make up the present-day life of society. To the extent that we fail in our efforts at coordination, the complex social machine of which we are a part goes awry, yielding not plenty and profit but conflict and confusion. Therefore, we might conclude that we are in danger of being plagued by our own knowledge of material things. It manifests itself as a web of exquisite subtlety which, unwittingly, we have been weaving about ourselves. And unfortunately there appears to be no way in which the web can be unraveled. Knowledge once available is destined to be a permanent possession; for all our inventive skill we can conceive of no method by which facts once understood can be forced back into the limbo of the mysterious and the unknown. The road of learning which the human race has been traveling permits of motion in only one direction. To go backward necessarily implies that the species were to become something less than human.

Constraints of Industrialization

A chief source of disquiet is that modern science in its own attainments and in its practical applications has emphasized as never before the gulf which separates the remarkable powers and the equally remarkable limitations of the human mind. In the face of such demonstrated limitations, we must all at times—and especially in the present crisis—have wished that they were not immutable so that something might be done to improve the breed, as it were. However, whatever the view we take toward eugenic programs and the uplifting influence of education, the only hope of prompt relief appears to lie elsewhere.

The mathematicians and physicists have a term which expresses precisely the change which accumulating knowledge seems to have made in our lives. There are in mechanics many problems which involve what are called constraints. The motion of the pendulum bob is a problem involving a very simple type of constraint. The string or wire which supports the pendulum weight converts the problem from that of a freely falling body to one which is compelled to oscillate to and fro indefinitely. The analogy is a good one, for our machines as they become hourly more complex and with more delicately balanced and interrelated parts, are constraining our lives to do likewise. Having created all manner of mechanical devices as aids to living we—as a people with instincts for gears and levers and close coordination—hesitate to sacrifice their marvelous efficiency by failing to meet the heightened standards of dexterity and cooperation on our part which their successful operation demands. The inevitable result is that our mode of living is becoming more and more determined by the presence of invisible but none the less compelling constraints.

What, then, is to be the antidote to our expanding knowledge of material things?

Alternatives Very Limited

This is not the place to discuss whether our association with the mechanisms of which the constraints are concomitants imparts adequate recompense for the resulting loss of freedom. Time alone will answer this question. But since most of mankind gives evidence of being fascinated by mechanism as well as welcoming the excitement of teamwork—that is, of being a cog in a machine provided only that the machine appears to be going somewhere or accomplishing something and is running rapidly enough—it seems reasonable to suppose that the growth of constraining influences will of itself scarcely be regarded as an unwelcome curtailment of action.

But whether this is so or not, we are faced with a startlingly limited array of alternatives. Recent events in Europe are of course the chief source of evidence in this regard. Should this nation or any western nation decide now or at some future time that the machine era has, so far as it is concerned, begun to display diminishing returns, there might be little that it could do to extricate itself, for the constraints of the machine are not alone of a kind which *counsel* conformity on our part, they include another kind which might very effectively *compel* it.

To be sure, history records that no dictatorship has long endured, having always proved the prey of disruptive forces working either from within or from without or both. But in this respect will history be able to repeat itself? We lack no evidence that through science and engineering the essential paraphernalia of dictatorship are much more effective than ever before. It is probably not wide of the truth to say that a few squads of men with modern tanks

are about as effective for purposes of offense as one of Caesar's entire armies. The unarmed mob, which in the past has so frequently been able to take matters into its own hands, is no longer a match for as much as a corporal's guard equipped with machine guns of recent design. And as a means of holding whole populations in submission, the airplane may prove itself to be a very decisive weapon. It has amply demonstrated that in densely peopled areas it can, unless strongly opposed, be the means of levying heavy toll upon civilian life and property, and apparently upon something even more vital, namely, civilian morale.

So it seems manifest that from the standpoint of the group—not alone the individual—we should regard very seriously the effort needed to overthrow authoritarian rule, once it becomes established; and this would be true even though it became utterly repugnant to its subjects. There is apparently something new to history—namely, the possibility that a minority can effectively secure control of a majority. We see not alone what can happen within national boundaries, as in each of the totalitarian states, but more significantly, we see an entrenched minority extend its sphere of conquest to much larger circles beyond its national boundaries.

While the full future consequences of these recent developments are not easy to gauge, it seems essential to attempt a re-evaluation of available political methods and instrumentalities, that we may thereby select those best suited to cope with the conditions obviously imposed by present-day technology. Our inherited social techniques give evidence of having lost an important measure of contact with reality. In an ideal sense one may still applaud Franklin when he said, "They that give up liberty to obtain a little temporary safety deserve neither liberty nor safety." But the vital fact to-day—and we see that it has but recently injected itself—is that a minority who are willing to sacrifice their own liberty, or who perhaps have been so unlucky as unintentionally to lose it, can compel a majority who cherish liberty to lose theirs. The most effective avenue of escape seems to be to find some way of preventing the minority from giving up their liberty. Failing this, little better than a Hobson's choice remains so far as the majority is concerned. They may elect either to lose their liberty by being worsted in a struggle for which they are improperly prepared, or if they act in time they may, by submitting in large measure to totalitarian methods, put themselves in condition to resist attack successfully. Now that mankind is in possession of the weapons made possible by modern technology, the planet has grown too small to support simultaneously the type of government which the modern dictators advocate and the type which we associate with liberalism. To combat the Nazi type of "total war" there is only one possibility—that of *total peace*.

The foregoing argument would only be strengthened were consideration given to such additional factors as wage, price and profit controls. Here again the liberal state as it now operates is at a distinct disadvantage. The authority necessary to establish such controls is entirely repugnant to the liberal way of life, except in so far as they can be worked out by voluntary acquiescence on the part of the individual. Yet the energetic waging of war—and in fact the energetic waging of commercial war in times of nominal peace—threatens to involve the equivalent of these authorities in the highly integrated modern industrial state and also in the world at large. In a word, unless the liberal nations, and those who would be liberal, have the world largely to themselves so that they can control the rules of the international game of give-and-take, they run a grave risk of proving but pawns in the hands of totalitarian powers.

Dangers in Planned Economy

Now it is proposed to discuss this situation not from the standpoint of the social sciences, but from that of the physical sciences and technology.

The purpose of the argument thus far has, of course, been to suggest that the free nations must alter in a fundamental fashion their methods of solving social and political problems. But let it be noted immediately that no planned economy will be advocated as the alternative. The gap which separates the planned economy from dictatorship is likely to be extremely narrow, if not in reality non-existent. It has frequently been pointed out that national planning, irrespective of the innocence with which it is launched or the beneficent ends held in view, will inevitably lead to dictatorship provided the political authority is created to enforce the plans when once they have been made. Time does not permit our retracing the argument to-day; suffice it that it has strong presumptive validity. As has already been noted, an increased complexity of function is being imparted to our social, industrial and political life by a growing technology; this demands a wider variety of specialized trainings and skills, and also calls for closer coordination between these specialized groups to the end that more rigidly guided and more narrowly confined spheres of action are imposed upon the individual. Since increasing emphasis upon specialization connotes planning while the increased need of guidance suggests dictatorship, we see that the two conditions are likely to merge *unless* great care is exercised to hold them apart.

Much depends upon that word "unless." What

procedures are at once compatible with preservation of the individual's freedom of action and yet with the need of circumscribing and directing his activities? There seems to be but one single practicable possibility, that of voluntary and educated guidance imposed by the individual himself, and consonant with enlightened public opinion. In other words, we can but base our policy upon the old political axiom that the source of all liberty is enlightened self-restraint. Before this audience it is not necessary to contrast the casual, not to say misinformed, methods frequently employed by representative governments in transacting their business, with the painstaking studies which underlie most operations of private business. Present-day evidence of faulty stewardship by representative government is swelling to such a volume that we are in some danger of being confused and misled by its very bulk. Haphazard political methods must go. The operation of government on the basis of uninformed popular hunch and whim, coupled with political self-interest, can only end in absurdity, if not in disaster.

Wider Knowledge Demanded

We are now at a stage where we possess "a little knowledge"—and are finding that it displays a peculiarly dangerous aspect. However, we will see clearly as we proceed that henceforth we must put our faith in the persistent and effective pursuit of broader knowledge, and at the same time give increased attention to its popular interpretation. This second point is as important as the first. Knowledge in the possession of a few who are without authority is powerless and useless, while knowledge in the possession of a few with authority to employ it is likely to be indistinguishable from totalitarianism. Final authority must be vested in the people if they are to retain their sovereignty, and understanding must be theirs too if the authority resting in them is to be used intelligently. Any other arrangement leads to concentrated control, since absence of control and likewise unwise control, under modern circumstances, are self-defeating alternatives.

Augmented knowledge seems, therefore, to be the sole key to liberalism's dilemma. The time has passed when, either in war or in peace, random and uninformed decisions in matters which at all vitally affect the body politic can be tolerated. Hence, what is now urgently needed is a new instrument of inquiry and investigation by which representative government, even in the face of novel circumstances, can educate itself "to act with vigor and economy," a phrase which you will recognize as borrowed from Henry Adams. It is his definition of an educated man, and it suggests precisely the status to which we must publicly attain.

In the search for an agency to be employed in the more effective pursuit of knowledge, we believe technology can offer a promising but as yet not widely recognized pattern.

It comes about in this way. To an increasing extent the larger problems of technology have become so involved that no single mind can cope with them adequately. As a concrete illustration—and no apology is made for the fact that it happens to be one with which the authors are especially acquainted—consider the dial telephone system as it now operates in a large metropolitan area. To any one at all familiar with the multitude of relays and opening and closing contacts, which must function to handle a single telephone call, the opinion will come as no surprise that it is one of the most complicated mechanisms yet devised. To comprehend it in all its ramifications, let alone to have developed, designed and built it, is a task probably beyond the capabilities of any single mind. Certainly, if its development and fabrication had waited upon the discovery of a sufficiently gifted individual who could have carried out the work himself, we might not have seen its completion for many a generation.

As an example the dial telephone serves our present purpose very well, but bear in mind that it is no more than typical. The importance of the illustration lies in the fact that instead of being content with the sort of undertakings that the individual human mind could handle, science (at least as concerns many departments) has forged ahead in the domain of organization and has succeeded in creating a sort of superbeing which is vastly more effective than the unit individual. Each modern, large industrial research laboratory, such as characterizes the electrical and chemical industries, is an instance of such a super-being. It is scarcely necessary to analyze the situation in detail. The basic fact is that more and more, due to his inherent limitations, the lone worker is being replaced by a carefully chosen corps whose various talents dovetail together and whose collective knowledge and collective analytical powers greatly exceed those of any single member of the group. When working as a unit, the capabilities of such a group, measured by results, are likely to exceed by a considerable margin the sum of any individual achievements possible to its members. In essence of course it is simply the division of labor applied in the intellectual field.

To make this fact a little more evident it might be mentioned that the laboratory with which the authors are associated comprises about 4,500 employees, one half of whom are skilled scientists and technicians, while the remainder include very essential laboratory assistants and service groups. Experience speaks so strongly that to-day no verbal argument is needed to

justify the existence of such a centralized research and development organization. No single individual, nor indeed a widely scattered but equal number of individuals, could hope to match the analytical and creative powers which such a laboratory, long accustomed to mutual effort, can focus upon its chosen field.

The German Method

Thus the physical sciences display a prototype of the exploratory organization with which it ought to be possible to attack our larger social, economic and political problems such as give evidence of having outgrown the reach of former methods of solution. Moreover, at least one illustration may be cited that the method of the industrial laboratory is already proving effective when thus transplanted. It should come to no one as a surprise that Germany under Hitler has become none other than a vast laboratory dedicated to the perfection of the arts of war. It is not necessary to hypothesize any unusual skill at organization to explain the startling character of recent Nazi military achievements. The answer lies in the simple fact that the present German technique applies systematically and energetically to the affairs of a nation at war the precise methods which have characterized much of American industry for a generation or more.

It is well to recognize the type of human machine against which at any moment we may be pitted; we have here unimpugnable evidence that to wage a modern war successfully, and against a nation which has purposely set itself up as a war machine, involves detailed cooperation among all of a nation's population groups. Such a war machine may not actually rank in mechanical complexity with the dial telephone exchange, but it is clearly one of the more involved creations of modern science and industry. If a potential enemy, under dictatorship, chooses to focus all his powers upon its operation and coordinate its functioning by the same carefully drawn schedules that characterize industry, he leaves little choice but for other nations to adopt the same concerted methods as himself.

We are now witnessing a contest of strength between types of organization. In war the totalitarian state is proving itself a most potent adversary. It may in fact go further and succeed in proving also to have great survival power following war, unless perchance experience ultimately reveals that there is no branch of the human race—not even the Teutonic—so constituted as to submit indefinitely to the degree of dictation and regimentation that totalitarianism involves. Much as one might wish otherwise, there is little comforting evidence that a population working under the duress of dictatorship will lose significantly in efficiency. Certainly if any people were ever bludgeoned into submissiveness it has been the Germans under Nazi rule—in spite of which they continue to carry out orders of state with notable efficiency. It remains of course for the future to reveal whether such will be the case in peace as well as in war. If it should, then a new world situation indeed has been created.

Difficult Problems of Peace

There are other reasons, however, and equally cogent ones, for believing that the time has come when a nation must institute a mass intellectual attack upon its social and political problems. For instance, was it not recent ways of peace which led to the present war? In other words, has the world yet learned to live at peace? Here it is that problems will arise whose calibre probably exceeds those presented by war, problems far exceeding the grasp of our present political methods of solution. Such problems become more and more the substratum of our daily lives in proportion as we base our livelihood upon the closely interrelated routine demanded by efficient operation of an industrial society. But the future prospect is certainly not one of unmitigated difficulty. Wise decisions and enlightened programs tend to induce a simplification of the political future. It is unwise and misguided national actions which lead us into political crises and morasses. Nevertheless, in the face of our growing involvement in the results of our own creative activity in the technological field, it behooves us to undertake a purposive improvement of those organizational forms which promise to be most effective knowledge-getters. Outstanding among these is the large research institution which assembles, in intimate association, a considerable number of experts whose professional knowledge and skills merge in harmonious cooperation.

It will already have occurred to the reader that the analogy between the manner in which a modern corporation employs its laboratory and the manner in which an equally modern state might employ a similar investigative and advisory body, is startlingly close. Therefore the argument will not now be labored. The only outstanding difference, and it is one which would not appear to be significant, is that in the case of the state with representative government the public is served by a corporation around whose board it occupies all the directors' seats. This is precisely the allocation of powers and duties which is contemplated in the formula, "Government of the people, by the people and for the people." Whatever advisory and investigative bodies the management of the state—that is, government—is authorized to create, the public as its own board of directors will be in possession of

the findings of such bodies and, moreover, can demand that its chosen representatives properly employ them in their acts and policies.

Lack of Laboratory Control

In advocating that for the more effective pursuit of the knowledge which efficient public management presupposes, the industrial laboratory offers an admirable starting point, certain fundamental difficulties should not be overlooked. Thus, the methods of attack in regard to problems of state must differ in certain regards from those employed in technology. As is universally recognized, the basis of the experimental method in science is deliberate control of the factors and parameters which enter any problem. This is quite possible when dealing with the inanimate, but by and large there will be scant opportunity for the employment of such arbitrariness when studying the questions involving animate creations. This limitation assuredly makes the approach more difficult but does not rule out the attractiveness of the mass attack; if anything, it makes it more imperative.

And by the same token we must not be discouraged by the observation that while the problems of technology are in considerable measure quantitative and therefore susceptible of being stated in concrete and uncontrovertible terms, the problems of government, in proportion as they are difficult, defy reduction to simple methods of measurement. Here again as the challenge mounts, the need of organized study and analysis surely increases. Moreover the quantitative character of industrial problems is frequently more apparent than real.

In the social sciences, as in industry, there would be need to reduce findings to terms suited to general consumption. One of the commonest charges against the scientist is that while he may be very successful in discovering new facts, he is likely to fail or be indifferent to the description of them in terms which the so-called popular audience can comprehend. Whether the fundamental scientist who is primarily engaged in charting unexplored territory is justified in more or less disregarding the charge—and doubtless most would agree that in large measures he does disregard it—the problem is one which the successful industrial laboratory can not set aside. Its principal duty, in fact, is so to interpret its findings and conclusions that management, who while highly skilled in many essential ways is not likely to be skilled in scientific principles and terminologies, can make its decisions intelligently in so far as they ought to take the work of the laboratory into account.

And, finally, an additional comment will help to clarify the discussion. It resolves itself in brief into the question of who gives the orders in industry, management or the laboratory. It is obvious that in all matters primarily technological the laboratory is, or ought to be, supreme. Its purpose is clearly not to attempt to carry out the whims of management; its duty and prerogative are to develop and urge new instrumentalities and, in its expert capacities, to advise management as to what projects may be embarked upon with reasonable assurances of technological success. In a very real sense, therefore, orders go from the laboratory up to management. Nevertheless, the duties and responsibilities of management remain clearly defined. In the last analysis all decisions are within its province and are its proper function. Aside from the aspects of the business which the work of the laboratory does not touch, it is the duty of management to decide what products of research shall be introduced into circulation, and when, as well as what, in general, the future projects of the laboratory shall be. But in many such matters a management that is well advised will earnestly solicit the full cooperation of the laboratory before pronouncing final judgment.

Existing Political Analogies

Summing this up very briefly, the plan under which industry operates is seen to epitomize much of the republican form of government that our founding fathers intentionally created for the United States as a whole.

And in this connection it is well to bear in mind that there has been much loose talk in recent years regarding the identity of republican and democratic forms of government. Such is far from the truth. A republic is characterized by elected representatives who act in accordance with their own best judgment; in a pure democracy, each question is settled in accordance with the will of the majority. The former has proved workable and most of us devoutly hope that it will preserve this merit; the latter has never been workable, and there is less chance for it in the future than there ever has been in the past. The distinction between a republic and a democracy is one which the fathers of our Constitution had very clearly in mind; to quote one of them, James Madison, in the Federalist papers—"Democracies have ever been spectacles of turbulence and contention and have ever been found incompatible with personal security and the right of property, and have in general been as short in their lives as they have been violent in their deaths."

Without entering upon a discussion of the relative practical merits of a republic versus a democracy, it is nevertheless reassuring in view of Madison's observation, that the suggested use by government of organizations of technical experts whose existence is a continuing one and whose function is advisory to the elected representatives of the people is in every respect a republican institution. The proposal does not imply that the people as a whole must weigh detailed

and involved evidence. It asks only recognition of the fact that over the years public respect for informed opinion has developed surprisingly, and hence will probably continue to rise. This in itself is a singularly notable phenomenon. No longer is the expert, and particularly the expert in science, the object of disdain or suspicion. Rather he is the medicine man of the present epoch and his word is usually accepted as authoritative. In other words the pragmatic success to which science and organized knowledge have attained has established a tradition that what counts in the world to-day is accuracy and truth, not guessing. This represents progress of the highest order. It means that the public mind is ready to accept a wider application of the scientific method—or the nearest approach to this method which is practicable in the affairs of state—and would bestow upon the information and conclusions thus provided the same high regard that it metes out to the more ordinary applications of logical investigation. In a word, that all-important person, the man-in-the-street, has become intuitively aware of a golden truth attributed to Marcus Aurelius, namely "To change thy mind and follow him who sets thee right is to be, nonetheless, the free agent that thou wast before."

However, it should be emphasized that there is still much room for progress in this respect. The many methods of inculcating a popular understanding and respect for the value of unbiased inquiry should receive even more earnest support than heretofore, and doubtless outstanding among these are the science columns of the daily press, the popular science journals and the science museums.

The Machinery for Political Investigation

It is not the present intention—nor indeed would space permit—to venture any detailed suggestion as to the various organizational mechanisms which might be set up to procure the knowledge which must be procured if the liberal form of government is to maintain its workability. At the same time nothing said here is intended to imply that the practical problem which must be solved is anything short of extremely difficult. Its solution will quite obviously call for a very high order of statesmanship and political invention.

Let us note, however, that suggestive models and experience are already available. As regards certain fields of science, routines are now in existence whereby an independent and highly competent group of experts may render advice to the Federal Government. These routines had their origin in problems arising during the Civil War, and with certain additions the routines have remained in effect. The body of talent which is on call for consultation is the membership of the National Academy of Sciences or such other experts as the Academy may choose to select. During 1917 the pressure of war work became such that need of closer advisory routines led to the creation of the National Research Council, a body subsidiary to the National Academy and one which has had a continuing existence. Finally, as a result of the present crisis, the machinery of cooperation between the Federal Government and the nation's scientists has been further enlarged by an Executive Order creating the National Defense Research Committee. It is interesting, but perhaps not overly significant, that it has been war or the threat of war which has led to the creation and the elaboration of this machinery as well as to the periods of its extensive use.

In conclusion, it seems likely that we are well launched upon an era during which all the existing advisory aids to the government, as well as others still to be created, will have to function with increasing vigor. Such an arrangement need not savor of bureaucracy. The sovereign people will still remain sovereign. But belated and constructive recognition will have been given to the fact, now abundantly clear, that the day is gone, and probably forever, when a successful state can base its policies upon clamor of pressure groups or upon the uninformed beliefs of the majority, even though measured numerically by tens of millions.

OBITUARY

FRANCIS HOBART HERRICK[1]

Francis Hobart Herrick was born in Woodstock, Vermont, November 19, 1858, the son of the Reverend Marcellus Aurelius and Hannah Andrews (Putnam) Herrick. He attended St. Paul's School at Concord, New Hampshire, was graduated from Dartmouth College in 1881, earned the degree of doctor of philosophy at the Johns Hopkins University in 1888, and received the honorary degree of doctor of science from Western University of Pennsylvania in 1897 and from Western Reserve University in 1936. Immediately after having received his doctorate at the Johns Hopkins University he came to Western Reserve University as instructor in biology, to found what has since become a great university department of biology, including zoology, physiology and botany with their allied specialties. In 1891 he was appointed professor, and assumed permanent directorship of the laboratory. He retired from active service in 1929, becoming professor emeritus.

[1] From a tribute at memorial services in Amasa Stone Chapel, Western Reserve University, September 14, 1940.

Professor Herrick was a fellow of the American Association for the Advancement of Science and of the American Ornithologists' Union; he was an associate of the American Museum of Natural History; he held memberships in the American Society of Naturalists, the American Society of Zoologists, the Boston Society of Natural History and the Wilson Ornithological Club; he was a founder, trustee and vice-president of the Cleveland Museum of Natural History.

His bibliography, published in 1938, includes approximately 130 titles, beginning in 1883 with his "Prairie Warbler in New Hampshire" and closing in October, 1937, with two articles on Audubon. This covers an active productive period of fifty-four years. Professor Herrick's intimate associate, Professor Visscher, calls my attention to the fact that this entire period falls roughly into three epochs so far as specialized interest is concerned. The first, devoted to the development and morphology of crustacea, comprises his important publications on the American lobster; the second may be called the Audubon period, in which was produced his definitive biography of Audubon; the third and final period was devoted to a study of the American eagle, which in many ways epitomizes his life-long work on the habits, the origins and the development of instincts of wild birds.

Such are the brief but pregnant annals of his rich life. They give but an imperfect picture of the teacher, the scientist, the cultured gentleman, the friend whom we knew and loved.

Immediately upon his coming to Western Reserve University certain traits and ideals became instantly apparent, of which evidence is seen again and again in his writings, in his addresses and in what we remember of his conversations. I refer particularly to his insistence upon the educational principle that the way to know nature is to observe her face to face, to his appreciation of knowledge of nature as an important cultural element in the life of our great city as evidenced by his early proposals in 1890 for the establishment of a museum of natural history, to his interest in art and his own fine performances in line and color as shown for example in his classic volume on the American lobster, to the high quality of his literary expression, as evidenced particularly, I think, in his life of Audubon, to his sense of humor and his kindness of heart, to his love of animals (Can we ever forget his favorite dog, Douglas?), to his ceaseless urge to intellectual activity, and to the breadth of his reading and the philosophical depth of his thinking.

In his foreword to Howard Corning's edition of "The Journal of John James Audubon, 1840–1843," he emphasized in Audubon what he himself exemplified, namely, "his indefatigable industry, his singleness of purpose and his kindness of heart."

And so finally, using words with which he closed his account of the life of Audubon: On the eleventh of September, 1940, Francis Hobart Herrick died "as gently as a child composing himself for his beautiful sleep."

WINFRED GEORGE LEUTNER

MARY VAUX WALCOTT

MARY VAUX WALCOTT (Mrs. Charles D. Walcott) died in her sleep on August 22 at the home of her dear friends, the Henry Phipps Rosses, at St. Andrews, Canada. She had just passed her eightieth birthday, when a warning heart attack made her realize her long life of activity and independence was closing down.

She was an extraordinary woman. In early years she was a well-known glaciologist, studying the recedence of glaciers on the North American continent. She was the first woman to climb Mt. Stephen in the Canadian Rockies and did so much toward the development of that beautiful country that a mountain was named for her, Mount Mary Vaux. She was director of many charities in Philadelphia, with a full and active life of varied interests, including a successful dairy farm, when, at the age of fifty-six, she married Dr. Walcott.

Then followed thirteen years of perfect companionship in a life of different activities, of wide social contacts, of scientific interests. Dr. Walcott encouraged her to continue her hobby of painting wild flowers and finally to publish the beautiful books of North American Wild Flowers, which will always be a lasting memorial to her name.

The friends she made, the associations she formed during those years were continued and added to, after Dr. Walcott's death.

Instead of a lonely widow marking time, she pushed ahead her forceful life of usefulness and accomplishment. Her church, the Society of Friends, had no adequate meeting house in the nation's capital. The newly elected President, Herbert Hoover, was a Friend. So she decided to have a Meeting House built in Washington. She raised the money, bought the land, and built the beautiful building that will always stand as a symbol of the quality and character of the Quakers.

Mary Walcott had the simplicity and naiveté of a child, with the business astuteness and driving force of a master of men. Entirely self-reliant, she drew people to her by the force of her independence and character. She helped, materially and inspirationally, all she came in contact with who needed help, and

the love and tributes from her many friends were always a source of wonder to her.

A completely rounded life was hers—full eighty years of leading toward that goal of Christian civilization that in the course of history, in spite of the setbacks of wars and periodic decadence, makes man go forward.

H. W. Y.

SCIENTIFIC EVENTS

CHANGES IN MEDICAL PRESCRIBING IN GREAT BRITAIN

A correspondent of the London *Times* states that important changes in medical prescribing in Great Britain are recommended by an official medical committee composed of eminent members of the profession. The object of the recommendations is to support the government policy of avoiding the use of foreign currency, and also cargo space to bring to this country materials which are not sufficiently necessary to justify importation in war-time.

After surveying the drugs commonly used in medical practice, the committee has compiled a list of those which it considers are not essential. The attention of general practitioners, the pharmaceutical departments of hospitals and manufacturers of chemical preparations and proprietary articles is to be drawn to this list, with the recommendation that the drugs specified shall be prescribed and used sparingly.

Many of the items in the list of some seventy drugs are in frequent use, among them being the following: aconite, from Germany, Switzerland and France; balsam of tolu, from Colombia (South America); buchu leaves, from South Africa; agar, from Japan; calumba root and strophanthus seed, from Mozambique; cantharides, from U.S.S.R., Spain, Hungary and China; black catechu, from North Borneo; balsam cophiba, from northern South America; coriander seed, from Morocco, U.S.S.R. and Central Europe; cassia bark, from China; gelsemium root, from U.S.A.; gentian root, from France, Italy, Germany and Spain; witch hazel bark and leaves, from U.S.A.; jalap, from Mexico; krameria, from Peru; lobelia herb, from eastern U.S.A.; camphor oil, from Japan; psyllium seed, from Mediterranean countries; seneca root, from U.S.A., and tamarinds, from the West Indies.

The committee suggests substitutes which may be used in place of the drugs which it is undesirable to import in war-time. Adequate supplies of the substitutes are available, and in the opinion of the committee they possess therapeutic properties similar to the drugs which they will replace.

MEETING OF THE INDUSTRIAL RESEARCH INSTITUTE

The Industrial Research Institute, Chicago, met on September 27 and 28, at Swampscott, Mass. Problems of industrial research management and of the design of research laboratories were discussed by some fifty active executives in this field. Following the meeting it was announced that an inventory would be made by member companies of the special facilities and key personnel of their research organizations in the interests of the national defense program. Nathaniel McL. Sage, director of the Division of Industrial Cooperation, Massachusetts Institute of Technology, was guest speaker at a dinner tendered the members of the institute and their guests by the United Shoe Machinery Corporation following inspection of the company's new research laboratory at Beverly, Mass. Mr. Sage discussed the administrative problems of educational institutions in the present defense emergency.

The Industrial Research Institute, an affiliate of the National Research Council, was organized several years ago for the purpose of improving efficiency and effectiveness in the management of industrial research, through cooperation of its members. The membership is composed of industrial concerns maintaining research laboratories as a part of their organizations. The executives in charge of research of the member-companies represent them in the activities of the institute.

The general meeting was preceded by a session of the Institute's Executive Committee on September 26. H. Earl Hoover, vice-president of the Hoover Company, Chicago, is chairman and presided. Other members of the committee attending were:

L. W. Wallace, director of engineering and research, Crane Company, Chicago, vice-chairman of the institute; H. W. Graham, director of metallurgy and research, Jones and Laughlin Steel Corporation, Pittsburgh, past-chairman of the institute; R. B. Colgate, director, Colgate-Palmolive-Peet Company, past-chairman of the institute, Jersey City; F. W. Blair, chemical director, Procter and Gamble Company, Ivorydale, Ohio; R. C. Newton, chief chemist, Swift and Company, Chicago; Maurice Holland, director, Division of Engineering and Industrial Research, National Research Council, New York, and Caryl P. Haskins, president, The Haskins Laboratories, New York.

At the business session the members voted to cooperate in a survey of special facilities and key personnel of their respective research organizations in the interest of the national defense program. Dr. Caryl P. Haskins was elected a member of the executive

committee. Announcement was also made of the election of Alexander Smith and Sons Carpet Company, Yonkers, N. Y., to membership in the institute, with A. G. Ashcroft, director of research, as its representative. It was also announced that the office of the secretary was being moved from New York to 8 South Michigan Avenue, Chicago, in order to be near that of the chairman, H. Earl Hoover, vice-president, The Hoover Company. Dr. Maurice Holland, director of the Division of Engineering and Industrial Research of the National Research Council, will continue to represent the institute at its New York office.

"UNLIMITED HORIZONS," A WEEKLY BROADCAST

"UNLIMITED HORIZONS," a new weekly broadcast series devoted to the physical sciences, will be heard over the Blue Network of the National Broadcasting Company beginning on Friday, November 1, at 11:30 P.M., Eastern Standard Time. The series will be presented in cooperation with the University of California, Stanford University and the California Institute of Technology.

The first program, "Science—Bane or Blessing?" will be a round-table discussion on science and its influence on society. Dr. Robert Gordon Sproul, Dr. Ray Lyman Wilbur and Dr. Robert A. Millikan, presidents of the three cooperating universities, will be the participants. The other broadcasts are:

November 8—"Heavenly Bodies"—Astronomy, featuring contribution to this science by the California Institute of Technology. Dr. J. A. Anderson, Dr. Edwin Hubble.

November 15—"The Klystron and Radio Beams"—The story of Stanford University Department of Physics' development of a new radio tube which has been a boon to the aviation industry. Professor David L. Webster, Professor William W. Hansen, Sigurd Varian and Russell H. Varian, research associates.

November 22—"Unearthing the Past"—Story of paleontology by the University of California. Description of prehistoric life. Short-wave pick-up from diggings in the slopes of Mount Diablo. Dr. Charles L. Camp and Professor Ralph W. Chaney.

November 29—"How to Cultivate Plants and Influence Growth." Department of Plant Nutrition at California Institute of Technology discusses Vitamin B—its discovery, development and present-day use. Dr. F. W. Went and Dr. James Bonner.

December 6—"Faults of the Earth"—Stanford's Department of Mechanical Engineering tells of earthquake research. Professor Lydik S. Jacobsen.

December 13—"The Science of Sound"—The Department of Physics of the University of California presents a discussion of the scientist's findings in the strange realm of sound. Dr. Vern O. Knudsen.

December 20—"Wings on Man"—Department of Aeronautics of Stanford and California Institute of Technology—meteorological development in relation to aviation. Professors Alfred S. Niles and Elliott G. Reid, of Stanford, and Dr. von Kármán, Professor Clark Millikan and Dr. Irving Krick, California Institute of Technology.

December 27—"Salmon Savers"—Stanford School of Biology tells of early work in conservation of salmon on Pacific Coast, and recent developments in the modern salmon pack. Professors Paul J. Beard and Willis H. Rich.

January 3—"Building by Breaking"—A description of the giant universal testing machine, which exerts a tension of three million pounds and compression of four million pounds, from College of Engineering, University of California. Dr. Raymond E. Davis.

January 10—"Cosmic Rays—What Next?"—Department of Physics, California Institute of Technology, discusses Dr. Robert A. Millikan's work on cosmic rays and the results of his recent trip to India in the study of this phenomenon. Dr. Robert A. Millikan.

January 17—"Millions to Burn"—From Ryan Laboratory of Stanford University Department of Electrical Engineering. A discussion of modern experiments in transmitting high voltage over long distances. Professors Fred E. Terman, Joseph S. Carroll and William G. Hoover.

January 24—"The Cyclotron and the Atom"—The world's greatest atom-smasher. From the Radiation Laboratory of the University of California, a description is given of the giant 225-ton cyclotron, now in full research program. Interviews with Dr. E. O. Lawrence, inventor; Dr. Donald Cooksey and staff associates.

ELECTION OF OFFICERS OF THE AMERICAN CHEMICAL SOCIETY

THE election of seventy-two chemists to administrative and editorial posts in the American Chemical Society has been announced by Dr. Charles L. Parsons, secretary of the society. Officers were chosen by seventeen of the professional divisions, as well as by the local section officers' group and the divisional officers' group. Editors and associate editors of five scientific publications were named, and a member of the Council Policy Committee was reelected.

Changes have been made in the names of two divisions. The Division of Microchemistry becomes the Division of Analytical and Micro Chemistry, and the Division of Paint and Varnish Chemistry will henceforth be known as the Division of Paint, Varnish and Plastics Chemistry.

The society, which now has approximately 25,300 members, has undertaken, as already reported in SCIENCE, a census of all chemists and their experience in the interest of national defense. Nearly 3,000 new members have been elected to the society during 1940.

Establishment of a new local section with headquarters in Cumberland, Md., and territory comprising Allegany, Garrett and Washington Counties in Mary-

land, to be known as the Western Maryland Section, has been authorized. Ninety-two other local sections are located throughout the country. The next semi-annual meeting will be held next April in St. Louis, Mo.

The new divisional officers are:

Division of Agricultural and Food Chemistry: Chairman, Gerald A. Fitzgerald, of the General Foods Corporation, New York City; *Vice-chairman*, Ellery H. Harvey, of Highland Park, Ill.; *Secretary-treasurer*, Professor Carl R. Fellers, of Massachusetts State Agricultural College.

Division of Analytical and Micro Chemistry: Chairman, Dr. G. E. F. Lundell, of the U. S. Bureau of Standards; *Vice-chairman*, George L. Royer, of the American Cyanamid Company, Bound Brook, N. J.; *Secretary-treasurer*, the Reverend Francis W. Power, of Fordham University.

Division of Biological Chemistry: Chairman, Dr. Herbert O. Calvery, of the U. S. Department of Agriculture; *Secretary*, Professor Erwin Brand, of the Columbia University School of Medicine.

Division of Cellulose Chemistry: Chairman, Dr. William O. Kenyon, of the Eastman Kodak Company, Rochester, N. Y.; *Vice-chairman*, Dr. Elwin E. Harris, of the Forest Products Laboratory, Madison, Wis.; *Secretary-treasurer*, Dr. Charles R. Fordyce, of the Eastman Kodak Company.

Division of Chemical Education: Chairman, Professor Rufus D. Reed, of New Jersey State Teachers College, Montclair; *Vice-chairman*, Nicholas D. Cheronis, of the Chicago City College, Chicago; *Secretary*, Professor Paul H. Fall, of Hiram College, Ohio; *Treasurer*, Professor Virginia Bartow, of the University of Illinois.

Division of Colloid Chemistry: Chairman, Professor Arthur M. Buswell, of the University of Illinois; *Vice-chairman*, Frederich Olsen, of the Western Cartridge Company, East Alton, Ill.; *Secretary-treasurer*, Dr. W. O. Milligan, of the Rice Institute, Houston, Texas.

Division of Fertilizer Chemistry: Chairman, Dr. H. B. Siems, of Swift and Company, Chicago; *Secretary*, Charles A. Butt, of the International Agricultural Corporation, East Point, Ga.

Division of the History of Chemistry: Chairman, James F. Couch, of the U. S. Bureau of Agricultural Chemistry and Engineering, Philadelphia; *Secretary-treasurer*, Professor Ralph E. Oesper, of the University of Cincinnati.

Division of Industrial and Engineering Chemistry: Chairman, Professor Barnett F. Dodge, of Yale University; *Vice-chairman*, Walter A. Schmidt, president of the Western Precipitation Company, Los Angeles; *Secretary*, Whitney Weinrich, of the Gulf Research and Development Company, Pittsburgh.

Division of Medicinal Chemistry: Chairman, Dr. Russell J. Fosbinder, vice-president of the Maltbie Chemical Company, Newark, N. J.; *Vice-chairman*, Professor John H. Gardner, of Washington University, St. Louis; *Secretary-treasurer*, Dr. John H. Speer, of G. D. Searle and Company, Chicago.

Division of Organic Chemistry: Chairman, Professor Nathan L. Drake, of the University of Maryland; *Secretary-treasurer*, Professor Arthur C. Cope, of Bryn Mawr College.

Division of Paint, Varnish and Plastics Chemistry: Chairman, G. G. Sward, of the National Paint, Varnish and Lacquer Association, Washington, D. C.; *Chairman-elect*, Shailer L. Bass, of the Dow Chemical Company, Midland, Mich.; *Secretary-treasurer*, Adolf C. Elm, of the New Jersey Zinc Company, Palmerton, Pa.

Division of Petroleum Chemistry: Chairman, J. K. Roberts, of the Standard Oil Company of Indiana, Chicago; *Vice-chairman*, Professor M. R. Fenske, of Pennsylvania State College; *Secretary-treasurer*, Dr. Cary R. Wagner, of the Pure Oil Company, Chicago.

Division of Physical and Inorganic Chemistry: Chairman, Professor John G. Kirkwood, of Cornell University; *Chairman-elect*, Professor W. Conard Fernelius, of the Ohio State University; *Secretary-treasurer*, Dr. Ralph E. Gibson, of the Geophysical Laboratory, Washington, D. C.

Division of Rubber Chemistry: Chairman, Roscoe H. Gerke, of the United States Rubber Company, Passaic, N. J.; *Vice-chairman*, John N. Street, of the Firestone Tire and Rubber Company, Akron, Ohio; *Secretary*, Professor Howard I. Cramer, of the University of Akron; *Treasurer*, C. W. Christensen, of the Rubber Service Laboratories Company, Akron.

Division of Sugar Chemistry and Technology: Chairman, R. Max Goepp, Jr., of the Atlas Powder Company, Wilmington, Del.; *Vice-chairman*, Sidney M. Cantor, of the Corn Products Refining Company, Argo, Ill.; *Secretary-treasurer*, B. Whitman Rice, of the National Sugar Refining Company, New York City.

Division of Water, Sewage and Sanitation Chemistry: Chairman, Professor Charles R. Hoover, of Wesleyan University; *Vice-chairman*, Louis F. Warrick, of the Wisconsin State Board of Health; *Secretary-treasurer*, Professor Frederick G. Straub, of the University of Illinois.

The Division Group Officers have reelected Professor Cliff S. Hamilton of the University of Nebraska as chairman, and Professor Buswell as secretary.

Dr. Jacque C. Morrell, associate director of the Universal Oil Products Company, Chicago, has been chosen chairman of the Local Section Group Officers; Dr. F. O. Rice, of the Catholic University of America, is chairman-elect, and Auburn A. Ross of Eli Lilly and Company, Indianapolis, Ind., secretary.

Two associate editors of the *Journal of the American Chemical Society* were elected for five-year terms as follows: Professor Werner E. Bachmann, of the University of Michigan; Professor Henry Gilman, of the Iowa State College. Associate editors of the *Journal of Physical Chemistry* for a term of two years are Professors W. H. Rodebush, of the University of Illinois, and I. M. Kolthoff, of the University of Minnesota.

Professors L. O. Brockway, of the University of Michigan, and C. G. King, of the University of Pitts-

burgh, will be associate editors of *Chemical Reviews* for a term of three years. Dr. William A. Noyes, of the University of Illinois, was reelected editor of the scientific monographs for three years. The following associate editors were named: Dr. William Mansfield Clark, of the Johns Hopkins University; Dr. Louis F. Fieser, of Harvard University; Dr. Samuel C. Lind, of the University of Minnesota, president of the society; Dr. Linus Pauling, of the California Institute of Technology.

Dr. Harrison E. Howe, of Washington, D. C., continues as editor of "Technological Monographs" for three years. Associate editors will include Dr. C. H. Mathewson, of Yale University; Dr. W. G. Whitman, of the Massachusetts Institute of Technology, and Dr. F. W. Willard, of the Nassau Smelting and Refining Company, New York City.

Dr. Lundell and Professor H. H. Willard, of the University of Michigan, will serve on the advisory board of the analytical edition of "Industrial and Engineering Chemistry."

Dr. Gustavus J. Esselen, of Boston, was reelected to the Council Policy Committee for three years beginning on January 1, 1940.

SCIENTIFIC NOTES AND NEWS

DR. E. B. FORBES, director of the Institute of Animal Nutrition at the Pennsylvania State College, has been elected a foreign member of the Royal Swedish Academy of Agriculture.

DR. EDWARD W. BERRY, professor of paleontology and provost of the Johns Hopkins University, has been elected a corresponding member of the Academia Nacional de Ciencias, Cordoba, Argentina.

THE Sir Henry S. Wellcome Gold Medal for 1940 and a cash prize of $500 were presented to Captain Lucius W. Johnson, medical corps, U. S. Navy, by the Association of Military Surgeons at the annual meeting held at Cleveland on October 10, 11 and 12. The award was offered for essays on "Medical and Sanitary Care of the Civilian Population Necessitated by Attacks from Hostile Aircraft." Captain Johnson's paper will be published in *The Military Surgeon*.

THE Paris Academy of Sciences has awarded the Montyon Prize to Dr. Constantin Levaditi, of the Institut Pasteur.

AN international prize on the subject of encephalitis has been awarded by the University of Berne to Dr. Beppno Disertori, the Italian neurologist.

THE American Society for the Control of Cancer and its Women's Field Army have cited the following American women "for their significant contributions to cancer control": Dr. Maynie R. Curtis and Dr. Wilhelmina F. Dunning, of the Crocker Laboratory for Cancer Research, Columbia University; Dr. Elsie L'Esperance, founder of the Strang Clinic of the New York Infirmary for Women and Children; Elizabeth Fekete, Jackson Memorial Laboratory, Bar Harbor; Dr. Clara J. Lynch, Rockefeller Institute for Medical Research; Dr. Catherine Marfarlane, of the Women's Medical College of Philadelphia; Mrs. Robert G. Mead, New York City Cancer Committee; Dr. Anna Palmer, founder of the Cured-of-Cancer Club; Dr. Edith Quimby, Memorial Hospital, New York City; Dr. Mildred W. S. Schram, International Cancer Research Foundation, Philadelphia, and Dr. Maude Slye, of the University of Chicago.

AT the recent meeting in Cleveland of the American Congress of Physical Therapy, annual awards of merit were presented to Dr. Abraham R. Hollender, of Miami Beach, Fla.; Dr. George W. Crile, emeritus professor of clinical surgery of the Medical School of Western Reserve University; Dr. Disraeli W. Kobak, of Chicago; Dr. Malcolm T. MacEachern, of DePaul University; Dr. William F. Petersen, professor of pathology at the University of Illinois; Dr. Horatio B. Williams, Dalton professor of physiology and director of the department at Columbia University, and Dr. Charles F. Kettering, Dayton, Ohio, general manager of the research laboratories of the General Motors Corporation and founder of the Kettering Department of Medical Research at the Miami Valley Hospital, Dayton.

GUY EMERSON, of New York City, has been elected president of the National Audubon Society (formerly the National Association of Audubon Societies). Dr. Robert Cushman Murphy, who had been president for three preceding terms and a director for twenty years, was elected honorary president.

PROFESSOR ARTHUR W. HIXSON, professor of chemical engineering at Columbia University in charge of courses in process development and plant design, has been appointed head of the department of chemical engineering.

DR. F. F. LININGER, head of the department of agricultural economics of the Pennsylvania State College and Agricultural Experiment Station, was recently appointed vice-dean of the School of Agriculture and vice-director of the station. Dr. M. A. Farrell, associate professor of bacteriology, has been named professor of bacteriology and head of the new department of bacteriology.

Dr. W. S. Gillam, assistant professor at Michigan State College, has been appointed assistant professor in agricultural chemistry at Purdue University to fill the vacancy arising through the resignation of Dr. Dale H. Sieling, who was recently appointed research professor in the department of chemistry of the Massachusetts State College.

The following changes at dental schools have been announced recently: At the University of Nebraska, Dr. Bert L. Hooper has replaced Dr. George A. Grubb. At the University of Illinois, Dr. F. B. Noyes has been succeeded by Dr. Howard M. Marjerison, previously dean of Tufts Dental College. The vacancy in the deanship at Tufts was filled by the appointment of Dr. Basil G. Bibby, of the School of Medicine and Dentistry of the University of Rochester. At the Ohio State University, Dr. H. M. Semans, one of the oldest dental deans from the point of period of service, has been succeeded by Dr. Wendell D. Postle. Dr. H. V. Cottrell, for many years secretary of the Dental College of the Ohio State University, has been succeeded by Dr. Paul C. Kitchin. Dr. Balint Orban, formerly of Vienna and recently with the Northwestern University Dental School, has been appointed a member of the staff of the Foundation for Dental Research of the Chicago College of Dental Surgery. Dr. Josef Weinmann, formerly of Columbia University, has also joined the staff.

Professor Hudson Hoagland, director of the physiological laboratories of Clark University, has leave of absence for the year 1940–41, which he will spend as research associate in physiology at the Harvard Medical School.

Dr. Eliot C. Williams, Jr., during the past year a university fellow at Northwestern University, has been appointed assistant to the director of the Chicago Academy of Sciences.

Dr. George M. Sutton, curator of birds at Cornell University, and Dr. O. S. Pettingill, instructor in zoology at Carleton College, plan to make an ornithological expedition into Mexico during the birds' breeding season from February to June, 1941. Headquarters will be at Rancho Rinconada, in southwestern Tamaulipas. It is also planned to work at San Luis Potosi, Vera Cruz and Hidalgo.

Professor Enrico Fermi will speak before members of the New York branch of the American Association of Scientific Workers and their guests at the Men's Faculty Club of Columbia University at 8:15 P.M. on November 1. His subject will be "Latest Research on Cosmic Rays." A dinner for members will be held at 6:30 P.M. at the Faculty Club.

Dr. W. M. Stanley, of the Rockefeller Institute for Medical Research, Princeton, N. J., gave during October a series of three lectures on viruses on the Hitchcock Foundation of the University of California at Berkeley.

Dr. Tenney L. Davis, professor of organic chemistry at the Massachusetts Institute of Technology, addressed the October meeting of the American Academy of Arts and Sciences on "The Identity of Chinese and European Alchemical Theory."

At the meeting of the Society of Medical History of Chicago on November 4, illustrated addresses will be given by Dr. Abraham Levinson on "Medical Medallions," by Dr. James E. Lebensohn on "Wollaston and Hemianopsia," and by Dr. Jerome Head on "Bretonneau, Trousseau and Velpeau."

Dr. Christian A. Ruckmick, secretary and general sales manager of the C. H. Stoelting Company, Chicago, gave an address on October 10 before the Industrial Management Society in Chicago, entitled "Scientific Advancement of Unskilled Employees to Skilled Occupations by Application of Practical Tests."

Professor L. C. Dunn, executive officer of the department of zoology at Columbia University, writes that it has been visited by thieves and the following optical equipment has been stolen: Spencer research microscope #112538, Cat. type 7-H with binocular body, 16 m/m objective #276803, 4 m/m objective #287632; 2 m/m oil immersion lens, Spencer #17763; binocular Spencer microscope #112846; binocular Spencer microscope #112535; monocular microscope Spencer #115601, and monocular microscope Spencer #115185. The department would be grateful for a report from any one who discovers any of these numbers in other laboratories.

The fortieth expedition of the department of tropical research of the New York Zoological Society under the directorship of Dr. William Beebe has returned from two months' field work at the society's laboratory at New Nonsuch, Bermuda. Among the staff were Miss Jocelyn Crane, Greame-Kelley and Bronson Hartley. Satisfactory progress was made in continued studies of the life histories of fish and crabs.

With the purpose of encouraging the publication of books and monographs of scientific importance by members of the Harvard Medical School and the Harvard School of Public Health, and of adding to the distinction both of the two schools and of the Harvard University Press by publishing under their auspices a noteworthy series of monographs in medicine and public health, a sum of money has been provided, to be used for an experimental period of three years, as a revolving publication fund. An editorial committee consisting of Dr. A. Baird Hastings, chairman, Dr.

Walter B. Cannon, Dr. James Howard Means, Dr. S. Burt Wolbach and Dr. Katherine R. Drinker, executive secretary, has been appointed to administer this fund and to select books and monographs to be included in a series entitled "Harvard University Monographs in Medicine and Public Health."

THE American Dental Association this year appropriated $23,000 for investigation and research on dental problems. This is an increase of $6,000 over last year. Of this increase, $5,000 will go toward the establishment of a fellowship in dental research at the National Institute of Health.

THE Hooker Scientific Library, conducted as a non-profit institution by Central College, has inaugurated a new service for chemists who lack convenient access to chemical reference works. For a nominal fee the library will send data on any question which can be answered by reference to a chemical manual, dictionary or index. Inquiries taking too much time for the low fixed rate will be answered at a proportionately higher cost, for which estimates can be rendered in advance. Full details will be sent in response to requests addressed to Hooker Scientific Library, Central College, Fayette, Mo.

SIXTY professional gardeners are registered this term in the two-year Science Course offered by the New York Botanical Garden. The first session was held on October 7 and the classes will continue through December 23. These are the largest classes in the history of this course, which was inaugurated in 1932. Dr. B. O. Dodge, plant pathologist, lectures on Plant Pests and Diseases, and Dr. F. W. Kavanagh on Soils and Fertilizers. In addition to the student gardeners at the Botanical Garden, the class includes employees of the New York City Park Department, professional gardeners who were registered last year in the practical course, and several employees of florists and nurserymen, as well as gardeners on estates in and around New York. Some of the students come more than sixty miles to the class each week. In the two-year course in practical gardening which meets every Thursday evening for a study of Cultivation of Trees and Shrubs under P. J. van Melle, of Poughkeepsie, there are about ninety students in attendance. They include a number of men and women aiming to develop their home grounds, professional gardeners desiring further instruction in their field, and teachers, lawyers, lecturers, executives and other business people.

DISCUSSION

SOME ADDITIONAL OBSERVATIONS ON SLUMPING AND GULLY FORMATION

SINCE slipping is important to the engineer, landscape architect and soil conservationist and since it may occur under somewhat different circumstances, we are recording some additional observations of this phenomenon which have occurred under different conditions than those previously recorded for the hillside in question.[1] The present observations are significant because a rain gauge located about 75 feet away from the slip makes it possible to obtain exact data relative to the rainfall conditions where slipping has occurred and because the conditions of cover have changed since slipping was last observed on the hillside.

During the night of October 6, 1936, a mass of 170 cubic feet of material slumped 3 feet down the west slope of what is known as Flag Pole Hill on the campus of Muskingum College in New Concord, Ohio. For a period of 12 hours, beginning in the afternoon of October 6, 1939, a rain gauge about one mile south of New Concord indicated that $4\frac{1}{2}$ inches of rain had fallen, most of it—perhaps 3 inches—fell in the space of one hour. Considerable gullying occurred on the hillside during this period.

The slope was immediately graded and sown to grass and pine trees were planted below the slipped area up to the top of the clay upon which the slipping had occurred. Until recently no further slumping or gullying was noted.

Observation of this hill was again made on April 22, 1940, after a week of almost daily rainfall, during which time the rain gauge on top of the hill registered a total of 4.7 inches. At this time a roughly triangular-shaped area had slipped down the hill from 2 to 3 feet. The slip took place along three planes, one extending in a northwest-southeast direction for a distance of 30 feet, the southeast or uphill edge of which joined another slip plane extending for 10 feet in a north-south direction. This plane was joined at the south end by a plane extending southwest for a distance of 25 feet. From the south end of the north and south trending plane a smaller plane having a displacement of a few inches extended southward for a distance of 10 feet.

The material which had slipped down hill formed a roughly triangular terrace-like area 5 feet high and 30 feet across, tapering to the southeast and southwest for a distance of 20 feet. Several of the small pine trees, 3 or 4 feet in height, had been tilted and one had been pushed over and partly covered by the slipped material.

Several small terrace-like areas whose fronts were

[1] Robert H. Mitchell, SCIENCE, 84: 2184, 420, November 6, 1936.

4 to 5 inches high occurred on the slope above the main terrace, suggesting multiple slipping. This idea is strengthened by the fact that a number of wrinkles resembling small overturned folds occurred on the surface of the large terrace.

Extending southward from the base of the main slip for a distance of 36 feet creep had occurred, forming a terrace whose front was 2 feet high and 6 feet wide. The uphill side of this creep was scarcely discernible except for the steepened slope, since the grass was not seriously disturbed. Gullying on the slope was negligible.

The slip took place on a clay layer about 11 feet above the horizon of the Harlem coal. The material above the clay became saturated with water after a week of almost daily rain. The rain gauge 75 feet above the slip showed the following rainfall record: April 11–12, 1.2; April 15, 0.5; April 16, 0.2; April 17–18, 0.7; April 19–20, 3.3.

When the area was previously studied in 1936 the hillside had just been graded and prepared for grass. No trees had been planted on the slope. At that time 4.5 inches of rain fell in less than 12 hours. The recently observed slip occurred at the same location and on the same clay layer, but after the hillside was well covered with grass and the lower slope planted to trees up to the clay layer and after 4.7 inches of rain had fallen during a week's time. At both times the same clay layer was responsible for the slip after about the same amount of rain had fallen.

The significant difference in conditions under which slumping took place in 1936 and recently lies in the fact that the slope in the first case had no cover of any sort, while in the recent case it was well covered with grass. Another notable difference was in the nature of the rainfall; in 1936 the rainfall was concentrated into a few hours, while in the recent situation about the same amount of rain fell but it was distributed over a period of one week.

Since the quantity of rainfall in both cases was similar we might conclude that slumping may take place in certain areas underlain by clay when a condition of sufficient saturation is reached, whether the slope is covered or not. It is also significant that gullying has been checked by a good cover of grass and trees. Grass and small trees, however, were not sufficient protection against slipping when the condition of saturation was reached. It, therefore, becomes apparent that in this and similar situations the engineer, landscape architect and soil conservationist can not depend on cover alone for protection from slipping.

The fold-like wrinkles which occur on the surface of the terrace formed of slipped material in several cases had become arcuate when they occur just above a tree. The convex side of the arc is on the uphill side away from the tree. This condition indicates that the trees had a tendency to hold the slip. Since some of the trees near the toe of the slip had been moved and one had been overturned it is doubtful that trees would have entirely prevented slipping, though had they extended above the slip area, it is possible that they would have modified the slip and permitted less movement.

ROBERT H. MITCHELL
MUSKINGUM COLLEGE

MATING AND OVIPOSITION IN THE PACIFIC COAST TREE TOAD

IN connection with studies on the biology of amphibia the writer has had opportunity to make certain observations on the mating behavior of the Pacific Coast tree toad (*Hyla regilla*). Since there is apparently no previous account of this in the literature, the following may be of interest.

The beginning of the breeding season of *Hyla regilla* is marked by the congregation of large numbers of vociferous males at transient rain pools and more permanent bodies of water. The female does not enter the water until ready to deposit the eggs; the entry is ordinarily made in late afternoon or early evening, and mating and egg laying completed by the following morning. Since the females enter singly or in small groups, the superior number of males makes probable an immediate mating. By continued observation of hylas collected in the San Francisco Bay region, the details of amplexus and oviposition in this species have been learned.

A preliminary period of clasping is usual before laying begins. In the laboratory this varies from 4 to 24 hours, while in nature it is probably not longer than 4 to 9 or 10 hours. The amplectic posture is of the pectoral type with the male dorsal to the female. The forelegs of the male, placed directly behind those of the female, strongly constrict her in that region. Ordinarily there is no contact between the bodies of the pair behind a point just posterior to the pectoral girdle of the male. The hind legs of the male are folded as if in a sitting position and usually do not touch the female except when directly employed.

Insemination occurs at the moment of egg extrusion. The male brings his cloacal aperture close to that of the female, discharges a quantity of transparent semen, and with a quick, firm extension slides his feet posteriorly over the sides and hips of the female, then deftly retracts to his normal position. Simultaneous with this foot action, the female extrudes a clutch of eggs into the cloud of sperm about her cloaca. Some time before releasing an egg mass the female often

scratches at the surface of the substratum on which the eggs are to be deposited. As the eggs are extruded the cloaca is brought into close contact with this surface and attachment is thus effected. The female removes any eggs which may partially adhere to the cloaca during extrusion by a precise flexor-extension reflex of the hind legs. In this the tarsi are applied directly to the adhering eggs and a slow extension effects the removal.

Deposition of an egg mass is usually followed by a quiet moment during which the bodies of the pair become slightly more inflated than normally. The intervals between egg deposition, ranging from 2 to 10 minutes or longer, are spent in bursts of vigorous activity, mainly on the part of the female. What function this may serve, if any, is conjectural, but it apparently takes place under natural as well as artificial conditions. In the laboratory such periods are followed by a rest and then further oviposition. Shortly after laying is complete, the pair becomes separated. The entire time in amplexus has been observed to range from 8 to 40 hours or more.

The total number of eggs deposited was found to range from 500 to 750; however, Storer[1] reports an instance of 1,250 eggs being laid. The number of eggs per clutch is usually about 16, but varies from 5 to 60. Further, a tendency exists toward the close of the laying for the size of the clutch to taper off to 3 or 4 or even single eggs. There is indication that the embrace of the male may be requisite to the proper extrusion of eggs by the female. Three gravid females, isolated without mates, laid only 26, 92 and 80 eggs, respectively, on the evening following capture, and all three died during the ensuing day. The evidence at hand indicates that resorption of eggs does not occur in the gravid, unmated female. It would thus appear that retention of the eggs is fatal to the animal.

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THE PROPOSED TERMS "EXERGONIC" AND "ENDERGONIC" FOR THERMODYNAMICS

THE terms "exothermic" for reactions giving off heat and "endothermic" for those absorbing heat were coined in the last century when it was hoped that a concentrated attack on thermochemistry would solve the problems of chemical affinity and enable the chemist to predict the direction of spontaneous chemical reaction. This hope was illusory, but the nomenclature is quite useful and may also be applied to reactions for which the decrease in heat content $-\Delta H$ is positive or negative, respectively.

Those reactions do go spontaneously for which the entropy of the system and surroundings increases.

1 T. I. Storer, *Univ. Calif. Publ. Zool.*, 27: 225, 1925.

This criterion of the second law of thermodynamics is rather general, and it has been found more convenient to particularize the law with reference to the free energy F and use the criterion that a reaction will go by itself if the free energy decrease $-\Delta F$ is positive at constant pressure and temperature, or in other words, if useful work (rather than heat) could be produced by a reversible mechanism. An interesting chemical analysis of the correlation of these two thermodynamic criteria has been given by T. W. Davis,[1] since the change in entropy ΔS is negative for many reactions for which $-\Delta F$ is positive and reaction occurs spontaneously. The importance of free energy in chemistry is so great that G. N. Lewis and M. Randall[2] included it in the name of their classical book that crystallized the course of research in chemical thermodynamics.

No terms have received wide acceptance which aptly characterize so-called spontaneous and nonspontaneous reactions. We therefore propose that the term "exergonic" be applied to reactions which can produce work, and "endergonic" be applied to those on which work must be expended to cause the reaction to occur. At constant pressure and temperature exergonic signifies $-\Delta F$ is positive, and endergonic signifies $-\Delta F$ is negative.

These two words are derived from the Greek *ergon*, work, and are etymologically analogous to the corresponding thermochemical terms derived from *thermē*, heat. The word *ergon* was formerly used as a synonym for the unit of work, the erg, and in a more restricted sense applies in physics to a unit of work measured in heat. This application of the cognate word is consistent with modern scientific usage to express free energy values and changes in calories.

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1 *Jour. Chem. Educ.*, 13: 376 (1936).
2 "Thermodynamics and the Free Energy of Chemical Substances," McGraw-Hill Book Company, New York, 1923.

SAT-CHROMOSOMES

THIS technical term, introduced by Heitz,[1] is widely misunderstood and has been misused repeatedly in cytological literature. "SAT" is an abbreviation[2] of "Sine Acido Thymonucleinico." "SAT-Chromosome" is not a synonym for satellited-chromosome but signifies either a satellited chromosome or a chromosome with a secondary constriction that is associated with the formation of the nucleolus. All satellited chromosomes are SAT-chromosomes, of chromosomes with secondary constrictions, some are SAT-chromosomes,[3]

1 E. Heitz, *Planta*, 12: 775–844. 1931.
2 E. Heitz, *op. cit.*, p. 812.
3 L. Geitler, "Chromosomenbau," Berlin, 1938, p. 24.

some are not. The term "Nukleolenchromosom," perhaps best translated "nucleolar-chromosome," may be used as a synonym for "SAT-chromosome," although, as Heitz[2] points out, the two terms are supplementary rather than identical in meaning.

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SCIENTIFIC BOOKS

INFLAMMATION

Dynamics of Inflammation: An Inquiry into the Mechanism of Infectious Processes. By VALY MENKIN. New York: The Macmillan Company, Experimental Biology Monographs. 1940.

As the title indicates, the book presents one aspect of the broad subjects of inflammation and infection. The author reviews the significant contributions he has made to knowledge of inflammation and correlates them with the observations of others. He has been chiefly concerned with the fixation of injurious agents at the site of inflammation, the influence of inflammation upon the invasion of bacteria and the relation of inflammation to immunity.

The introduction is a brief review of the history of knowledge concerning inflammation up to and including the contributions of Cohnheim and Metchnikoff. Conventional subjects of dispute among those who have been interested in inflammation are fortunately ignored. It is doubtful if the opinions of Virchow concerning inflammation have been wholly abandoned, as the author states, for some modern writers still include parenchymatous degeneration in the domain of inflammation and existing nomenclature of disease perpetuates his influence upon knowledge of the subject.

Inflammation is broadly defined by the author as the complex vascular lymphatic and local tissue reaction elicited in higher animals by the presence of microorganisms or of non-viable irritants. The difficulty of finding a satisfactory definition of inflammation has been very great, and it is probable that this, like many other definitions of inflammation, will not be widely acceptable. The author's point of view is well expressed by the statement that an inflamed area is shunted off from the rest of the organism; it has its own metabolism, hydrogen-ion concentration and modified circulation.

Several chapters define the conditions under which dyes, foreign proteins, inanimate particulate matter and bacteria are fixed at the site of inflammation so that they fail to enter adjacent lymphatics, regional lymph nodes and circulating blood. The mechanism of this fixation, the author finds, is the deposit of a fibrinous network in the tissue and the occlusion of lymphatics by fibrinous thrombi. The significance of actual occlusion of lymphatics by thrombi may be questioned because the flow of lymph from the inflamed part is increased.

His observations on the local fixation of bacteria, measured by the fixation of a colloid dye (trypan blue), at the site of inflammation produced by staphylococcus, pneumococcus and streptococcus, suggest to him an explanation of the divergent ability of these microorganisms to invade the tissues. Staphylococcus aureus produces inflammation that within one hour prevents the penetration of trypan blue from the site of inflammation into regional lymphatics, whereas with pneumococcus this interval is six hours and with hemolytic streptococcus approximately 45 hours.

Observations confirming those of others are described to show that an exudate acquires increased acidity in the later stages of an inflammatory reaction. Parallel with this change, and, he believes, consequent upon it, polymorphonuclear leukocytes are replaced by macrophages. Macrophages survive and predominate when the pH falls to a level of about 6.9 or 6.8. Acidity, the author finds, is in part at least the result of glycolysis and the appearance of lactic acid in the exudate.

Menkin has sought for some substance that puts in motion the phenomena of inflammation and thus explains their apparent uniformity under very varied conditions. He finds evidence that histamine can not be accepted as the agent which, set free by injury of tissue, explains the ensuing vascular and cellular changes. He has extracted from exudates a crystalline, doubly refractive nitrogenous substance which contains amino- and carboxyl groups. It is not protein, but its chemical composition is not more exactly definable. It increases the permeability of blood vessels to fluids and to dyes and induces the migration of leukocytes. It does not produce in the body the well-known reactions of histamine. The author has designated this substance leukotaxine and thinks that the available evidence supports the opinion that increased permeability of blood vessels and leukocytic migration are referable to it. Nevertheless it should not be forgotten that there are a great number of substances, including many degradation products of proteins, that cause the same changes.

This monograph is an admirable presentation of its subject from the standpoint of experimental biology. The important contributions of the author and his clear definition of some of the problems of inflammation

will doubtless stimulate renewed investigation of them. The book reveals very fully the fundamental significance of inflammation in relation to infection and immunity.

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PHOTOELASTICITY

Elasticité et Photoélasticimétrie. By H. LE BOITEUX and R. BOUSSARD. 361 pp. Paris: Hermann and Cie, 1940. 180 francs.

ALTHOUGH the technique of photoelasticity, a practical method to determine complicated two-dimensional stress distributions experimentally, was originated in France by Mesnager in 1901, this is the first French book giving a comprehensive account of the theoretical and practical aspects of the method. It is divided into four sections, of which the first is an exposition of the theory of elasticity in the classical manner. The second section does the same for optics, first of isotropic and later of anisotropic mediums. These two sections comprise half the book and do not as yet mention photoelasticity. In the third section the two theories are combined and a discussion is given of apparatus, experimental techniques and properties of the materials used. The last quarter of the book is devoted to methods of numerical integration for finding the principal stresses individually, which is necessary since the photoelastic pictures only determine the difference between these stresses at each point. It is noted that the authors show a number of colored pictures of stress distributions, which represented good practice a decade ago. Although the superiority of monochromatic light and black-and-white pictures over colored pictures is casually mentioned in the text, the authors evidently do not use the improvement in their own laboratory.

A very complete and encyclopedic book, entitled "A Treatise on Photoelasticity," on the subject was published in 1931 by Coker and Filon (Cambridge University Press) which from a technical standpoint is now somewhat out of date. The present French volume is more clearly written; it is easily readable and presents the theory quite adequately; but, although appearing nine years later, it is no better than Coker-Filon in the technical parts of the subject. And it is just in the technical direction that great advances have been made lately, making the now obtainable accuracy in reading stresses about ten times better than that shown in the book.

Another recent volume on the subject written by Mesmer is entitled "Spannungsoptik."[1] The first half of its total of 220 pages follows the French book in its general structure, while the last half discusses experimental techniques and the more modern applications. The bibliography appended refers principally to the last decade, listing 240 papers published since 1930, whereas the French bibliography practically stops with the year 1931.

The most interesting recent development of photoelastic technique is its extension to three-dimensional stress distributions. This is done by exposing the bakelite model to a load at a fairly high temperature and then cooling it under load. A subsequent removal of the load leaves the model without stress but with optical properties that can be correlated to the stress that existed in it before the load removal. Although not yet developed to the point of being a practical engineering tool, this method shows great promise of becoming such a tool in the near future. It is discussed briefly by Boiteux-Boussard as well as by Mesmer.

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[1] Berlin: Julius Springer, August, 1939.

SPECIAL ARTICLES

ON THE INTERDEPENDENCE OF RESPIRATION AND GLYCOLYSIS[1]

THE following definition of the Pasteur effect has recently been suggested by Burk:[2] (a) O_2 inhibition of fermentative processes, and at times also (b) O_2 stimulation of anabolic syntheses, the latter effect not being invariably concomitant with the former. Crabtree[3] in 1929 found that the respiration of transplantable tumors was about 12 per cent. lower in the presence of glucose than in its absence and suggested that glucolytic activity exerts a checking effect on the capacity for respiration of tumors. This phenomenon has been called a reversed Pasteur effect (or the Crabtree effect). The occurrence of the Crabtree effect in transplantable tumors has been confirmed.[4,5] Likewise, the effect was observed in lymph nodes of leukemic mice.[6]

We have noticed that the inhibition of respiration by the addition of glucose occurs also in normal tissues with an aerobic glucolysis. In the renal papilla of the rat, which is known to have a metabolism similar to tumors,[7] the inhibition amounted to 20 per cent.

[1] From the Laboratory of Orthopaedic Research of the Harrison Department of Surgical Research, Schools of Medicine, University of Pennsylvania, Philadelphia, Pa.

[2] D. Burk, Cold Spring Harbor Symposia on Quantitative Biology, 7: 420, 1940.

[3] H. G. Crabtree, *Biochem. Jour.*, 23: 536, 1929.

[4] E. Krah, *Biochem. Zeit.*, 219: 432, 1930.

[5] K. A. C. Elliott and Z. Baker, *Biochem. Jour.*, 29: 2433, 1935.

[6] J. Victor and J. S. Potter, *Brit. Jour. Exp. Path.*, 16: 253, 1935.

[7] P. György, W. Keller and Th. Brehme, *Biochem. Zeit.*, 200: 356, 1928.

In bovine articular cartilage which possesses an exceedingly low respiration and thereby a relatively higher aerobic glycolysis than the other tissues mentioned, the inhibition averaged 57 per cent.

Results of a representative experiment with calf cartilage are listed in Table 1. It is seen that glucose

TABLE I

THE ACTION OF GLUCOSE ON THE RESPIRATION OF CARTILAGE*
Mean rates over three-hour period

Substrates	None	Glucose	Pyruvate	Succinate	Glucose + Pyruvate	Glucose + Succinate
		(M/100)	(M/50)	(M/25)		
Q_{O_2}†	.079	.029	.079	.103	.062	.080
Inhibition by Glucose	...	−.050 (−63%)	...	...	−.017 (−22%)	−.023 (−23%)
Acceleration by Pyruvate and Succinate	...	...	±0	+.024	+.033	+.051

† Cmm. O_2/mg dry weight/hour.
* Articular cartilage from the metacarpal-phalangeal and metatarsal-phalangeal joints of a calf two months old. About 125 mg dry weight of cartilage slices per experimental vessel. k_{O_2} = .98
Gas: Air Medium: Phosphate-Ringer's

retards oxygen consumption by 63 per cent. Similar effects were obtained by the addition of mannose, but no effect was obtained with fructose which is not glycolyzed by cartilage. The inhibition observed in oxygen (53 per cent.) was of the same order as in parallel determinations in air (59 per cent.). The magnitude of the respiratory inhibition in cartilage is neither due to a drop in the pH of the medium incident to the high rate of acid formation after the addition of glycolyzable hexoses to the slices nor to an accumulation of glycolytic splitting products or their derivatives (lactate, pyruvate, succinate). Table 1 shows an example of the results obtained with pyruvate and succinate. Pyruvate does not alter the rate of the spontaneous O_2 consumption, but it induces an acceleration of the oxygen uptake if the respiration is inhibited by glucose. Succinate[8] accelerates respiration in the presence of glucose to a greater extent than in its absence. Apparently the addition of glucose suppresses cellular processes which result in the formation of pyruvic and succinic acids since the addition of these acids abolishes more than half of the respiratory inhibition by glucose (*cf.* Table 1).

Elliott and Baker[5] as well as Victor and Potter[6] observed that the retardation of respiration by the addition of glucose was paralleled by a rise of the R.Q., indicating a replacement of respiratory substrates of the tissue by the added glucose. The latter authors pointed out that the change of the R.Q. after the addition of glucose was compatible with a shift from protein oxidation to carbohydrate combustion. Warburg and colleagues[9] showed that the formation of ammonia in tissue slices deprived of glucose is especially high in glycolytically active tissues and that the addition of glucose inhibited the excretion of ammonia. This inhibition was considered an expression of the protein sparing action of glucose. The investigation of Dickens and Greville[10] indicate that the oxidation of glucose rather than its glycolysis is responsible for the retardation of the protein catabolism. It seems possible that the addition of glucose causes a decrease of oxygen consumption in such tissues in which the hexose is not oxidized with the same velocity as the cellular substrates, the oxidation of which it replaces. Such a mechanism would explain the frequent occurrence of the Crabtree effect in aerobically glycolyzing tissues where a relatively sluggish oxidation of glucose coincides with a high protein catabolism in the absence of sugar.

[8] Lactate behaves similarly.

This tentative explanation does not intend to imply that glucose oxidation replaced only the combustion of protein nor that glucolysis does not prevent to a certain extent protein catabolism, as was suggested by Warburg.[9] The explanation supports the view, however, that the Crabtree effect is not a reversal of the checking action of respiration on glycolysis but a separate process which indicates the sparing of cellular substrates by the combustion of extracellular glucose. Thus, the Crabtree effect may belong to the reactions which underlie the stimulative action of respiration on cellular anabolism (Pasteur effect b).

The mechanism of the effect is being investigated further.

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APPEARANCE OF SKELETAL ABNORMALITIES IN THE OFFSPRING OF RATS REARED ON A DEFICIENT DIET

The following observations were made when rats, which were reared on deficient diets, were bred. All rats used were of the Sprague-Dawley strain. One group of females was reared on a diet consisting of yellow cornmeal 76 per cent., wheat gluten 20 per cent., calcium carbonate 3 per cent., sodium chloride C.P. 1 per cent. (Steenbock and Black rachitogenic diet No. 2965),[1] which was supplemented with viosterol (each rat received 60 I.U. every tenth day). On this diet the animals were retarded in growth and

[9] O. Warburg, K. Posener and E. Negelein, *Biochem. Zeit.*, 152: 309, 1924.

[10] F. Dickens and A. Greville, *Biochem. Jour.*, 27: 1123, 1933.

[1] H. Steenbock and A. Black, *Jour. Biol. Chem.*, 64: 263, 1925.

development. The vagina opened at the age of three to four months, the regular cycles started at between four and five months, the first matings took place at between five and six months, at which age the rats weighed only about 150 grams. In this group of 18 animals, 32 pregnancies were observed. A total of 164 young was born either spontaneously or by cesarean section; of these, 107 were apparently normal, while 57 presented multiple congenital abnormalities.

An abnormally short mandible was found in 39 animals. This defect was so marked that the tongue was exposed to a large extent. Many animals also had deformed extremities. Syndactylism of different grades was observed in 32 young. A short tail was seen in 12 animals. One hundred and four of the young were cleared by the Spalteholz method to facilitate the study of the skeleton. In 42 of these specimens the lower legs showed reduction in size or absence of the tibia; in 20 the fibula was shortened or absent; in 22 there was fusion of the ribs; and in 14 there was fusion of the centers of ossification of the sternum.

Another group of females of the same strain was reared on a more adequate diet consisting of yellow cornmeal 78 per cent., wheat gluten 18 per cent., calcium carbonate 1 per cent., sodium chloride C.P. 1 per cent., and dried pig liver 2 per cent.[2] This diet resulted in much better growth and development of the animals. This group consisted of 24 females which had 39 pregnancies resulting in 294 young. None of the latter showed deformities of the mandible or extremities like those described in the previous group. The only external abnormality observed in the offspring of the animals on this diet was absence of the tail in one animal. Eighty of the 294 young were cleared, but they showed none of the skeletal deformities found in the previous group.

A third group of 12 female rats of the Sprague-Dawley strain was raised on an adequate diet (Bill's modification of Steenbock's stock diet).[3] Thirty litters born to these animals consisted of 216 young. One abnormal animal was noted in this group. It weighed only $2\frac{1}{2}$ grams and when cleared showed short femurs and an abnormal sternum. One hundred and nineteen young in this group were cleared, but they showed no abnormalities.

At the present time we are extending these experiments along both genetic and nutritional lines.

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[2] R. E. Remington, *Jour. Nutrition*, 13: 223, 1937.

[3] C. E. Bills, E. M. Honeywell and W. A. MacNair, *Jour. Biol. Chem.*, 76: 251, 1928.

MODIFICATION OF THE CHEMISTRY AND PHARMACOLOGICAL ACTION OF THE CARDIAC GLYCOSIDES[1]

ALTERATION of the molecular structure of a drug frequently results in modification of its pharmacologic action. The digitalis bodies exist in nature as chemical combinations of one or more sugars with hydroxylactones of sterol hydrocarbons. This suggests the possibility of modifying the digitalis bodies by replacing the sugar with a vasodilator, thus obtaining a cardiac glycoside molecule which might embody the desirable therapeutic actions of both drugs.

Two molecules of theophylline can be combined chemically with one molecule of a genin obtained by removing the sugar radical from a squills glycoside.[2] This dimethylxanthine genate can be prepared as short needle-like yellow crystals having a molecular weight of 758.2 and an empirical formula of $C_{38}H_{46}O_9N_8$ (presumably $C_{24}H_{28}O_3(C_7H_7O_2N_4)_2 \cdot 2H_2O$). When injected intravenously in cats the lethal dose of this theophyllinated genin is much greater than that which might be expected on the basis of the amount of genin used in its preparation. The lethal dose of a mechanical mixture of theophyllin and the genin, on the other hand, is in proportion to its genin content. The theophyllinated genin, the squills glycoside, the mechanical mixture, and also digitalis show the same progression of electrocardiographic changes; T wave inversion and ventricular premature beats occur with the same degree of frequency, while nodal rhythm and ventricular tachycardia appear after approximately the same percentage of the lethal dose. Changes in the S-T segment, however, appeared in a far lower percentage of the animals given the theophyllinated genin than in those given digitalis, squills glycoside or a mechanical mixture of theophyllin and the squills genin.

These preliminary studies suggest that dimethylxanthine and the squills genin have been combined in a single molecule retaining some of the digitalis-like properties and modifying others. Further studies of the chemical and pharmacological properties of this preparation are necessary as well as clinical studies to ascertain the therapeutic value of the drug.

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THE NATURE OF THE ANTI-ALOPECIA FACTOR

IT has recently been shown[1] that the mouse requires a new vitamin for normal growth and for mainten-

[1] From the Medical Research Department of the Beth Israel Hospital and the Department of Medicine, Harvard Medical School, Boston, Mass.

[2] This preparation was supplied by Parker Dorn, Inc., Worcester, Mass.

[1] D. W. Woolley, *Jour. Biol. Chem.*, 136: 113, 1940.

ance of hair. The dietary essential which prevented or cured the pathological manifestations was termed the mouse anti-alopecia factor. In its absence from the diet, growth ceased and extensive alopecia developed, followed by severe dermatitis. Liver was found to be a good source of the protective factor, and concentrates were prepared from this organ.

Many of the properties of the active substance suggested that a phosphoric ester of inositol was involved. For example, our best concentrates contained organically-combined phosphorus. The active substance was precipitated by barium hydroxide and was insoluble in alcohol. Furthermore, it was found that cereal grains, known to be good sources of the phosphoric ester of inositol, were also good sources of the anti-alopecia factor. All these facts seemed to justify a test of the potency of phytin, the salt of inositol phosphoric acid. While the assays were in progress, a crystalline substance was isolated from active liver concentrates which proved to be inositol. Phytin caused restoration of hair and resumption of growth in the depleted animals. Activity was not limited to the phosphoric ester, for inositol itself was subsequently found to be potent.

Assays were performed as described previously, and were always based on curative rather than preventative technique. For both phytin and inositol the level fed was 100 mg per 100 gm of ration. Cures have also been obtained with 10 mg of inositol per 100 gm of ration. Gain in weight, as well as restoration of hair, followed administration of these substances.

Inositol was isolated from the non-dialyzable, alcohol-insoluble portion of aqueous liver extract. This fraction had been autoclaved with alkali in order to render the active substance dialyzable. The crystals which were obtained melted at 214–216° and had a carbon content of 39.8 per cent. Inositol in the same bath melted at 215–216°.

The above facts indicate that the mouse anti-alopecia factor is inositol or its derivatives. They suggest that inositol exists in liver in alkali-labile combination with a large molecule which renders the former non-dialyzable. While it has been reported[2] that inositol stimulates the growth of certain strains of yeast, its place in the nutrition of higher animals has not previously been observed. Details of the work will be published elsewhere.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A NEW TYPE OF SHIELDED GLASS ELECTRODE[1]

The high resistance of glass electrodes and their consequent sensitivity to stray currents require careful shielding in addition to an adequate insulation. The shielding is important when the electrode is to be employed at distances from the measuring apparatus that require long leads. This shielding is ordinarily accomplished by the use of a more or less flexible metal sleeve, thus providing an equipotential layer around the lead. The sleeve is conveniently connected to the equipotential shield about the measuring apparatus. Commercially manufactured shielded wires are frequently employed.

The special feature of the shielded glass electrode now to be described is an arrangement by means of which the KCl-solution which ends in a fluid junction surrounds completely the stem of the electrode and the entire lead up to the terminal of the measuring apparatus. In this manner the KCl-solution that is a part of the low resistant half of the circuit acts as a shield against external stray currents. With our equipment best results were obtained when the terminal of the reference half cell was connected to the equipotential shield around the potentiometer or directly to the ground.

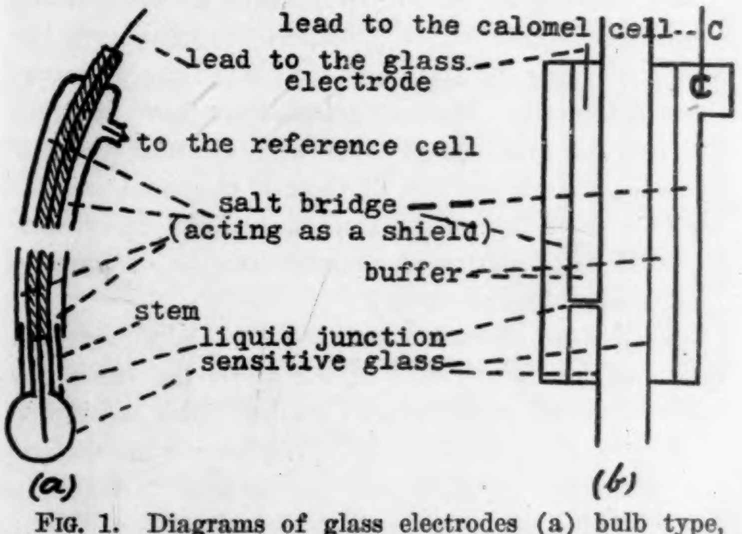

Fig. 1. Diagrams of glass electrodes (a) bulb type, (b) condenser type with the use of the salt bridge as a shield.

Fig. 1 shows two types of glass electrodes, the bulb type (a), and the condenser type (b), also used as a continuous flow electrode with the use of the KCl-solution as a shield.

The arrangement calls for a very careful insulation

[1] From the Laboratory for the Study of Peripheral Vascular Diseases, Department of Surgery, New York Hospital and Cornell University Medical College.

[2] E. V. Eastcott, *Jour. Phys. Chem.*, 32: 1094, 1928.

of the leading wire against the surrounding fluid. Its advantages are twofold: (1) With a metal shield there is always some space between the shield and the conductor, thus producing a condenser with the resulting disturbances usually seen on bending the metal shielded wire. In the type described, the KCl-salt bridge fills the space between the insulated wire and the outer cover entirely and follows uniformly any movement of the flexible lead. Merely a film of liquid or semi-liquid, as used in agar-KCl or similar bridges, is sufficient for the shielding. $BaSO_4$ or another x-ray-opaque material may be added when location of the electrode by fluoroscopy is desired. (2) The combination of the glass electrode and the reference half cell in one piece saves space and is easy to handle. Even a calomel or another reference half cell may be incorporated to form one piece with the electrode as seen in Fig. 1 b. The use of this type of shielded electrode is of particular advantage in the measurement of pH in body cavities.

A more detailed description of a measuring device, in which this type of shielded glass electrode is used in the determination of intestinal pH, with a report of clinical findings will be presented later.

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A DIRECT METHOD OF DETERMINING THE ERYTHROCYTE, LEUCOCYTE AND THROMBOCYTE COUNT OF FOWL BLOOD

A MODIFICATION of the Blain method of staining the leucocytes in bird blood yields a rapid, reliable means of enumerating the cellular elements of the blood in the counting chamber. Two solutions are employed, the first containing the stain and the second the preservative for the cells. Because granulocytes have an affinity for brilliant cresyl blue and lymphocytes for pyronin, a stock solution of these is prepared consisting of 1 cc of 1 per cent. aqueous brilliant cresyl blue and 0.25 cc of saturated aqueous solution of pyronin (1 gram in 15 cc of water).

The first solution for staining used in the method described herein consists of 0.2 cc of the stock dye mixture in 25 cc of normal saline. This is filtered once through neutral paper. The second solution is that employed by Blain—12 per cent. of formalin in Locke's solution.

Blood is procured from the wing vein, and immediately after puncture it is drawn up to the 1 mark in the red-cell counting pipette. The pipette is then half filled with the first solution, gently rotated for about five seconds, and then filled to the 101 mark with the second solution and shaken for half a minute to mix. Counts may be made at once, although better differentiation is obtained if the mixture is allowed to stand 15 minutes or more. Thin covers, not more than 0.5 mm in thickness, are used, and the preparation is studied under a 4 mm objective.

The erythrocytes appear as pale oval discs with the nuclei sometimes barely perceptible. The thrombocytes vary from pale ovals slightly smaller than the erythrocytes and with a single polar granule, to small lance-shaped, faintly lilac-colored bodies. The latter type tends to occur in clusters and is more numerous in specimens made just before clotting begins, *i.e.*, after one or more pipettes have been filled in succession from the same puncture. The heterophiles take varying quantities of the blue dye and stand out sharply as blue-black bodies slightly smaller than the erythrocytes. The lymphocytes are uniformly round, faintly pink bodies, clearly distinguishable from thrombocytes, which in their colorless state appear to belong more to the erythroblast series. Monocytes are indistinguishable from the large lymphocytes, but since this is not primarily a differential count, that is not important.

Checked against Shaw's method over a series of blood counts on the bobwhite quail, this method gives approximately the same total leucocyte count and has the added advantage that the solution is more stable than Shaw's. The solution containing the dye will keep for about a week. The stock solution is less stable, but the dyes kept separately in solution are good indefinitely. The formalin solution must be made fresh each day, but adjustment of the pH and temperature are unnecessary.

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